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ON THE

LOCAL TREATMENT OF PULMONARY CAVITIES BY INJECTIONS THROUGH THE CHEST-WALL.

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It is not difficult to explain the recent revival of interest in the attempt to employ direct local applications in the treatment of phthisical cavities in the lungs. Undoubtedly it may be partly traced to the increasing familiarity and confidence in the use of delicate trocars and exploring needles in puncturing different tissues for purposes of diagnosis or for the removal of morbid effusions. But even more largely is it to be traced to the recent modification of medical opinion as to the nature and prognosis of certain cases of pulmonary phthisis. As far back as our knowledge goes, there have been occasional reports of recovery of cases of reputed phthisis, and many of the older authors freely admitted the possibility of such an occurrence. It is difficult for us to determine at the present time how far this belief was unfounded, or how far it was justified by the actual results of their practice. Our greatest difficulty in appreciating the value of such opinions lies in the simple fact that all clinical histories of thoracic disease, published before the introduction of percussion and mediate auscultation, and where the diagnosis is not verified by post-mortem examination, are hopelessly vitiated. No one, even at the present day, when the knowledge of ætiology and symptomatology is so precise, would pretend to diagnose, without the aid of auscultation and percussion, between empyema with or without pulmonary fistula, chronic pneumonia, bronchiectasis with copious purulent secretion, and pulmonary phthisis. All who have critically studied such essentially diverse conditions as these—and their number might readily be increased—must be aware how deceptively similar the general symptoms are in certain cases, and how entirely we fall back upon the aid furnished by physical diagnosis. Yet it is in the face of this uncertainty as to the precise morbid condition present, that we are obliged

to accept the conclusions of medical authors before the days of Avenbrugger and Laennec, drawn from their treatment of cases of chronic thoracic disease. I call particular attention to this point now, because it will be seen later that the historical discussion of the local treatment of pulmonary cavities has been confused by the introduction of much of this defective and unreliable evidence.

Following the more precise study of the signs and lesions of pulmonary diseases inaugurated by Laennec, and the diffusion of his brilliant but too exclusive theories upon tuberculosis of the lungs, the most despairing views were adopted as to the prognosis and curability of pulmonary phthisis, under the idea that all cases where cheesy deposits and yellow granulations occurred were to be regarded as essentially tuberculous and incurable. It would be presumptuous as well as out of place at present, to speak decidedly as to the nature of certain apparently distinct lesions frequently met with in the lungs. The results of modern investigation have carried medical opinion on this subject first in one direction, then in another, and the remarkable discussion upon tuberculosis held at the sessions of the London Pathological Society, during the past winter, may be taken as proof of the difficulty of definitely formulating our present knowledge of the nature and relations of the various lesions known as true miliary tuberculosis, cheesy infiltration, and fibroid degeneration. But though it is probable that Niemeyer and his immediate followers were extravagant in their views of the essentially non-tuberculous character of many cases of pulmonary phthisis, the clinical fact remains that in different cases of phthisis the morbid process presents vast differences, both in its vital tendencies and gross anatomical characters; in its rapidity of development, tendency to extension and diffusion, and influence upon the general health. The attempted classification of phthisis has also been derided on account of the signal want of success of any of the plans of treatment which were introduced in consequence of the modified theory of the nature of the disease. Undoubtedly no specific has been discovered, nor is it possible that one ever should be. Unfortunately, also, no new remedies or new modes of using old ones have been introduced which have sufficed to very materially change the former well recognized course of pulmonary phthisis. But still it would be most short-sighted to deny that the whole discussion has been highly serviceable to the treatment of this complex condition. It reawakened an interest and enthusiasm in the attempts to cure phthisis, which is already bearing fruit in a more judicious adaptation of remedies to special cases; and in a more extended study of the influence of diet, and especially of climate, upon the different forms of the disease.

The recognition of the importance of inflammation as a cause of many of the lesions met with in phthisical lungs, and the fact of some cases depending in the early stage, if not throughout, upon an unhealthy low

grade of inflammation of the lung tissue, led me, so far back as 1867, to begin the consideration of the possibility of applying directly to the seat of the disease some of the alterative agents which prove so effectual in the treatment of analogous inflammatory states of external tissues. After passing in review the various modes by which this might be accomplished, I concluded that it could be most safely and satisfactorily done by passing a very delicate canulated-needle through the intercostal tissues into the diseased area, and injecting suitable fluids directly into the affected tissue. I began this mode of treatment of cases of pulmonary vomicæ in February, 1874 (*Phila. Med. Times*, March 14, 1874), and a few weeks afterwards received the number of the *Berliner Klinische Wochenschrift*, October 27, 1873, containing an account by Prof. W. Mosler, of Griefswald, of several cases treated in a somewhat analogous manner.

I have already spoken of a recent *revival* of interest in this question, but in reality the local treatment of vomicæ in the sense in which the term is here employed and in the manner which will be fully detailed, has never been attempted, so far as I am aware, until very recently. As this question has, however, given rise to some discussion, it may not be without interest to consider the following points :—

1st. The history of the direct local treatment of pulmonary cavities by thoracentesis.

2d. The indications it is designed to meet.

3d. The more recent methods proposed.

4th. The dangers and disadvantages of such treatment.

5th. The clinical results of this mode of treatment.

It is extremely difficult either to confirm or disprove the statements made that Hippocrates recommended puncturing pulmonary cavities. In very many places in the Hippocratic writings (both in those which are undoubtedly genuine, as well as in those which are plausibly attributed to some writers of the Cnidian school) we find mention made of empyema, of its diagnosis, terminations, and mode of treatment, in which paracentesis thoracis always has a place. In some instances the language used in describing the cases of so-called empyema is such as to have led the eminent scholar Littré (*Œuvres Complètes d'Hippocrate*, tom. ii. p. 97) and Francis Adams, the editor of the Sydenham Society edition of the genuine works of Hippocrates, to doubt whether this term was not sometimes used to denote phthisical cavities. The conclusion to which I have myself been led is that the cases of paracentesis referred to by Euryphon of Cnidos, by Hippocrates, Galen, Aëtius, Avicenna and Avenzoar, and by Rhazes, were performed for the relief of empyema. Owing, however, to the absence of any reliable diagnostic symptoms, it may be that in some instances pneumonic abscesses or even tuberculous cavities were punctured. It appears unlikely, however, that this latter lesion is intended

in their descriptions, since, as a rule, the operation is directed for the evacuation of a collection of pus, and very frequent mention is made of the external appearances which indicate the approach of the pus to the surface by ulceration of the intercostal tissues. So far as an analysis is permitted of the clinical histories of such cases they would seem to refer rather to the development of pyothorax than of pulmonary phthisis. It may at least be safely concluded that none of the older physicians designedly recommended or practised thoracentesis in cases of phthisical cavities in the lungs.

Still less can we determine from the writings of authors during the middle ages that this operation was ever performed at that time. Paracentesis, even for clearly recognized pyothorax, was almost abandoned: it being scarcely admitted, according to Trousseau (*Clinical Medicine*, Syd. Soc. Ed., vol. iii. p. 207), that there were any cases, except those of surgical lesions, in which the operation ought to be performed. Ullersperger, in his treatise on the curability of phthisis (*Die Frage ü. d. Heilbarkeit der Lungenphthisen*, Wurzburg, 1867, p. 234), affects to regard the puncturing of tuberculous cavities as a mere form of paracentesis for empyema, and quotes without hesitation, but without any proof, a list of nearly-forgotten writers as having performed it. So far, however, as can be inferred from their imperfect descriptions, there seems little doubt that the operations were performed for the relief of ordinary cases of empyema.

Coming to more recent times, when thoracentesis had regained favour and was made the subject of numerous treatises, we find Baglivi, in 1696, using the following language:—

"A phthisick arising from an ulcer is commonly branded as incurable, upon the plea that the ulcer is internal and occult, and cannot be cleaned like other external ulcers. But why do they not make it their business to find out the true situation of the ulcer, and make an incision accordingly, between the ribs, to the end that proper remedies may be conveyed to it? For my part, I know no reason why that should be neglected. About seven years ago, when I was at Padua, a man received a wound in the right side of his breast, that reached to his lungs, and, employing an able surgeon, had an incision made between the ribs to the length of six fingers' breadth, in order to discover the situation of the wound in the lungs, which was perfectly cured in two month's time, with vulneraries applied with tents and with syringes. Now practitioners ought to use the same piece of diligence in curing a phthisical ulcer in the lungs, lest the scroll of incurable diseases should grow too long, to the infinite disgrace of the profession."—*Practice of Physick* (English trans.), 2d edition, London, 1723, p. 301.

This is referred to by Ullersperger (*loc. cit.*), and is quoted in full by Hutchinson (*Phila. Med. Times*, May 30, 1874, p. 548), in a critique upon my former article on this subject, with the following comment: "We have sufficient evidence in the above that the propriety of establishing a communication between the lungs and the outer air through the walls of the chest, for the purpose of applying remedies directly to the seat of disease, in cases of phthisis, was entertained as early as the seven-

teenth century." Unquestionably credit must be given to Baglivi for the suggestion that such a procedure should be employed; but the very terms in which he advocates it sufficiently imply that its propriety was not entertained by physicians, while with himself it appears to have been a mere speculative idea, which he never attempted to carry out. As to the case which is so briefly narrated by Baglivi, it seems difficult to form any clear idea of the condition actually present. It can hardly be credited that an incision not less than four inches in extent was made down to the surface of the lung soon after a penetrating wound of the thorax. The favourable results often observed in such cases when the wound is quickly closed and the case trusted to nature, would render such an operation most improper. If pneumothorax did not already exist, it would certainly be induced. More probably the case was one of limited pleural abscess or empyema following a penetrating wound of the thorax. Many cases of this kind, treated in the same way and with equal success, are to be found in even older writings than those of the learned Baglivi.

A much more valuable contribution to this subject was made by Barry (*Treatise on Consumption*, 2d edition, London, 1727, p. 267), also quoted by Ullersperger and Hutchinson, who describes carefully the anatomical relations of phthisical cavities, pointing out especially that there is generally close adhesion between the pleuræ over their seat, so that an incision might be made into them without danger or difficulty. In his first publication, after discussing the operation with remarkable clearness, he says: "'Tis most certain that many phthisical persons may by this means be preserved, that will otherwise unavoidably perish. If the operation be rightly performed, there is great reason to expect success, neither if it fails can it be attended with any very great danger, or much contribute to hasten their fate." He adds, as another advantage of the operation, that "the ulcer may be more easily cured by deterging and healing injections." In his later publication (*Treatise on the Three Different Digestions*, etc., London, 1763, p. 360 *et seq.*), he repeats the same reasoning and advice, and gives several cases in which he had the operation performed. When we remember, however, that he had no better guide to direct him in his diagnosis than "to open the breast where the most frequent pain and oppression direct the situation of the ulcer," it is not surprising that it should appear doubtful, after a careful study of these cases (although accepted unquestioningly by Hutchinson), whether it was really a pulmonary cavity which was opened in a single instance. Certainly the clinical symptoms detailed are very unlike those so familiar in phthisis, and very similar to the phenomena of some cases of circumscribed empyema, in some instances opening into the lung tissue and partially discharging through the bronchi. Mosler refers to Barry's views as being without practical results, but this scarcely assigns to them their proper value, since not only did they lead Barry himself to attempt the opera-

tion, but it will be seen that more than a century afterwards they induced the performance of operations which anticipated, in many particulars, those of Mosler himself.

In the present century Richter (*Bemerk. ü. d. Lungensucht, in den gelehrten Götting. Anzeigen* 49. Stück v. 28. Marz., 1805, p. 481) recommends incising pulmonary cavities, and reports two supposed cases in which he operated successfully. In the first of these, redness, swelling, and fluctuation presented themselves in the fourth interspace, and an incision at this point gave exit to a large amount of pus, followed by recovery. In the second, the patient became phthisical after an attack of pneumonia. An incision was made over a spot where there had been fixed pain, fluctuation was detected, and 1½ pounds of pus evacuated, after which the patient gradually recovered.

These may be taken as illustrations of a number of cases which have been published before or since, where it is difficult to doubt that, although the operator recommended the operation with the deliberate intent of evacuating a phthisical cavity, he had in reality to do with a simple empyema, or possibly a true pneumonic abscess, though this latter lesion is so rare that it can hardly have existed in any large proportion of the cases recorded. Such cases were published by Herff, quoted by Canstatt (*Spec. Path. u. Ther., von Henoch*, 3te. Aufl. 2 Bd. p. 687), but I have not been able to get access to the original account.

Ramadge (*Consumption Curable*, London, 1836), who wrote a treatise characterized by the most unbounded egotism and ignorance of pathology, in support of his method of curing phthisis by forced inhalation, reports several cases where thoracentesis was performed. In the first case, called by him "supposed consumption cured by paracentesis," slight swelling presented itself two inches beneath the left nipple, and the heart was dislocated to the right; an incision through the intercostal tissues gave issue to yellow pus with a quantity of air which rushed out with a hissing sound. Unquestionably this was a case of pneumothorax following an empyema which had partly discharged through the lung. In the second case, styled "Consumption cured by Paracentesis," the clinical history, the description of the operation, and the results of post-mortem examination all show that the case was one of chronic plastic pleurisy, with fibroid change in the apex of the right lung, and that the operator merely introduced a trocar through the fourth intercostal space into comparatively healthy lung tissue, without causing any serious results. In his fifth case he describes the operation on a patient with phthisis, who had a chronic abscess in the apex of the left lung, as follows:—

"A trocar was introduced between the second and third ribs, in a line nearly perpendicular with the left nipple; very little matter escaped, as I had expected, for my chief object in performing this operation was to insure the emission of the air, and thus effect a diminution of the cavity by the expansion of the inferior lobe of the left lung. I kept the punctured place open for

about ten days, by the introduction of a small piece of catgut properly secured externally; when, finding that the cavity became so contracted, through the encroachment made on it by a general pulmonary expansion, as to preclude all further escape of air, I withdrew it. About this time a catarrhal affection of the inferior lobe of the punctured side supervened. In less than two months my patient was able to go out, and had completely lost his phthisical symptoms. In less than two years after the operation he was in the enjoyment of excellent health, the only drawback being the existence of catarrh, to which he more immediately owes his recovery."

It is evident that in all of these cases the intention was to directly open pulmonary cavities, though it may be doubted whether, even in the last case, the end was obtained. Certainly the procedure, undertaken with a most mistaken object, cannot be regarded as having had the slightest influence upon the condition of the patient. In a brief article published nine years later, Dr. Herbert, a pupil of Dr. Ramadge, states that "within eighteen months, he has been present at seven such operations performed under Dr. Ramadge's direction, and has in no case seen them attended with any inconvenience or followed by disagreeable consequences." (*Lancet*, 1845, vol. i. p. 75.) Unfortunately, this appears to be the sole record of the cases, and although it is evident from this that Ramadge continued to puncture chests where he supposed cavities to exist, in order to "give exit to the air," and "induce expansion of the surrounding lung tissue," it is impossible to determine the real nature of the cases operated on or the results of the operation. It is certain that the arguments by which he supported his practice very naturally failed to attract attention or to induce others to follow his example.

In the year 1845, Dr. Hastings and Mr. Storks (*London Med. Gaz.*, 1845, vol. xxxv. p. 378), published an interesting and well-observed case of pulmonary phthisis, with a large cavity at the left apex which was opened by the latter by an incision in the third interspace. A piece of gum-elastic catheter was introduced and worn constantly from the date of the operation, November 15, 1844, to December 23, 1844, which is the latest detailed report of the case. Pus was discharged through the tube from time to time, and it is reported by Dr. Hocken (*London Med. Gaz.*, 1845, vol. xxxv. p. 481 and 509),[1] who conducted the subsequent treatment of the case, that the patient's general symptoms improved, with a diminution in the cough and amount of purulent secretion. A still later report is made by Dr. Hastings (*London Med. Gaz.*, 1845, vol. xxxvi. p. 767), who, writing six months after the operation, says: "Although very weak, the patient has latterly been able to get out when the weather has been fine. His expectoration for the last two or three months has not averaged more than two drachms in the twenty-four hours."

[1] These are the papers referred to by Mosler, under the name of Hooken, with statement that he had been unable to discover them.

These authors quote Barry (*loc. cit.*) as their authority for the operation, but do not seem to have ever heard of the publication of Ramadge.

It is certainly not a little singular that after this time, the subject appears to have attracted no attention whatever, and that the remarkable cases to which we have above referred, should have induced none of the many physicians specially engaged in the study of pulmonary diseases to examine into the value of this simple operation. With the exception of a courteous, but not convincing critique by Campbell (*Lancet*, 1845, vol. i. p. 675), no discussion appears to have been aroused, and the matter fell into entire forgetfulness.

It is not alluded to by Trousseau in the exhaustive history of Thoracentesis in his *Clinique Médicale*, nor by Walshe, nor Copland, nor even by Waldenburg (*Die locale Behandlung d. Krankh. d. Athmungsorgane*, Berlin, 1872). Canstatt observes merely, in referring to the recommendations of Herff and Hocken, that they will scarcely find many followers, since, apart from the uncertainty of the existence of pleural adhesions, the emptying of a cavity could have no beneficial influence upon a disease, which is usually characterized by the formation of several cavities, and which springs from a general diathesis. And Bennett (*Reynolds' Syst. of Medicine*, first ed. vol. iii. p. 589) briefly says: "pulmonary cavities have even been opened from without, and variously treated with the view of causing cicatrization, but all such attempts have been, what an intelligent consideration of the pathology of the disease might have anticipated, a uniform failure."

It is difficult to explain the almost entire failure of this operation to attract even the criticism of eminent observers. It is true that it had been by some recommended for objects which were evidently unattainable, and that the cases which were given in illustration of its successful performance were so inaccurately reported as to afford no sound basis for its repetition, although neither of these objections can be brought against the case reported by Hastings. More probably it was condemned by medical pathologists on the ground that it was directed only against a local expression of an incurable constitutional disease. And it is also quite possible that some unfortunate cases which have not been placed on record may have helped to bring it into disrepute.

Within the past few years we find several observers engaged in the study of this subject. Thus in 1873, Dr. Wilhelm Koch published (*Langenbeck's Archiv. f. Klin. Chir.*, 15te Bd. 3te Hft.) the results of experiments which showed that injections of dilute solutions of iodine might be made with impunity into the lung tissue of dogs; and suggested, in consequence, that this mode of treatment might be applicable to some diseases of the lungs in human subjects. This article seems to have attracted no notice, and was unknown even to Mosler (*Berl. Klin. Wochenschr.*, No. 45,

November 10, 1873, p. 542), at the time of publication of his article referred to below.

The attention of the profession was more forcibly attracted to this subject by Mosler of Griefswald (*id. op.*, October 27, 1873), who appears to have been ignorant that the operation had ever been performed, merely stating that "such a proposition was made by Barry in 1726, and renewed later by Masse, v. Herff, Hooken (*sic*), without, however, any practical results."

In two cases he simply punctured the cavity with a "tolerably large canula" which was permitted to remain. In a third case he operated very much after the manner of Storks (*loc. cit.*), by making a long incision (3 ctm.) along the upper border of the 3d rib, and then gradually opening the wall of the cavity with a suitable pair of forceps, and introducing a pretty large silver drainage tube; but in addition he conjoined the use of medicated injections through the canula directly into the cavity. In the first case, one injection of dilute solution of permanganate of potash was practised; in the second, five were employed; and in the third case, their use, as well as that of dilute solution of iodine and carbolic acid, was continued for some time. The particulars of this interesting paper (*American Journ. of Med. Sci.*, July 1874, p. 253), are so fresh in the minds of our readers as to render further allusion unnecessary. Suffice it to say that in none of the cases did the slightest ill result attend the operation or the subsequent injections, and that in the only instance in which the latter were employed continuously, there was a positive improvement in the pulmonary symptoms, although death occurred three months subsequently from albuminoid degeneration of the kidney and spleen, associated with disseminated miliary tubercles in the left lung.

In February of the present year I began to treat pulmonary cavities by injecting dilute solutions of iodine through a delicate canula, and have continued to do so until the present time with results that will be given in detail at the close of this paper. At that time I was unaware that the local treatment of phthisical cavities had ever been attempted before, and it will be seen that the method which I have used differs in several very important respects from any hitherto employed.[1]

[1] The mere question of priority as to the idea of local treatment of pulmonary cavities seems to me very unimportant. In the London *Lancet* for March 28, 1874, Dr. Birkard states that he conceived this idea so long ago as 1872, and that lately he has injected a weak solution of carbolic acid through the thoracic parietes into the lung in a very bad case of phthisis. The injection seems to have been performed but once, and to have caused no inconvenience, but no details whatever are furnished. Prof. Mosler has been engaged upon the subject since the latter part of 1872. I have already alluded to my determination announced so far back as 1867: but Baglivi in 1696, although it is not probable that he ever carried it into execution, clearly expressed the suggestion that this local treat-

Before proceeding to speak of the actual results, so far as known, of the local treatment of phthisical cavities, it is proper to allude briefly to the indications which may be thought to present themselves in favor of this method, as well as to the objections which have been advanced against it.

It is very easy to overstrain the argument which is often drawn from the unfavourable nature of a disease in support even of the most unpromising plans of treatment. And yet, in the present discussion, it is but fair to bear in mind that the treatment proposed is for a condition which is universally conceded to be usually a mortal one. It is true that, in the earlier stages of phthisis, even after the general symptoms and physical signs positively indicate organic disease of the lung tissue, recoveries are not rarely observed. But after a cavity of considerable size has formed, even though it be single, the remaining lung tissue healthy, and the constitutional disease inactive, the course of the case is generally downward.

Pollock, in his masterly memoir on the *Elements of Prognosis in Consumption*, says:—

"The cure of cavity in the lung has long been a vexed question. I presume there is now no doubt in the minds of the most experienced observers that cavities close and heal up. If the cessation of all the physical signs of such a lesion, and the perfect restoration of health, be considered evidence sufficient, there are cases enough of this kind on record by good authorities to justify the opinion that this form of cure is possible. But all agree that it is not frequent; and its infrequency must be apparent from the facts that, out of an experience of 4530 cases, most carefully noted at the Hospital for Consumption by myself personally, I can only place on record 68 cases of well circumscribed cavity, with 13 presenting the characters of 'retracted cavity,' in all 81 *instances in which the patients seemed progressing towards a cure of cavity.*"

It will probably be the experience of most observers that, although 1.8 per cent. of patients with circumscribed cavities of considerable size may for a long time *seem progressing* towards a cure, a far less proportion will actually enjoy entire recovery.

The dangers which surround a patient with a pulmonary cavity are indeed serious. There is, in the first place, the risk of hemorrhage which, though rarely directly fatal, is often profuse. Granting also that the original disposition to tuberculous deposition has been expended, or that the cavity has proceeded from a non-tuberculous ulcerative process, recent observations have demonstrated the great danger of secondary constitutional infection and the development of miliary tuberculosis in cases where there are long-standing centres of softening caseous infiltration or of unhealthy suppuration. It should also be remembered, that, under the most favourable circumstances, patients with lung cavity are constantly in a state of feeble vitality, sufferers from harassing cough and dyspnœa on exertion,

ment was feasible. The only merit in question seems to me to be in connection with the actual demonstration of the feasibility and clinical value of making local applications by thoracentesis to lung cavities, the determination of the best manner of doing this, and the decision as to which cases are best suited for such treatment.

and liable to dangerous intercurrent attacks. Unfortunately, in the vast majority of cases we also find evidence that the diseased action is invading the lung tissue surrounding the cavity, and that the morbid process shows little tendency to become circumscribed.

The objects which have been sought by the ordinary methods of treatment in such cases, have been to remove the constitutional diathesis, to disinfect the discharge from the cavity, to check the paroxysms of cough, and to alter by counter-irritants, internal remedies, and inhalations, the morbid action in the walls of the cavity.

So it will be observed that the objects proposed by the authors who have recommended opening the cavity, are similar in character. It is true that Ramadge (*op. cit.*) advocated the operation with the curious notion that, by insuring the emission of the air, he could effect a diminution of the cavity by the expansion of the remaining portion of the lung, bringing the surfaces of the cavity into contact, so that they would unite and cicatrize. But Barry, in 1727 (*op. cit.*), recommends forming an artificial opening into the cavity, in order that the matter may be readily and completely discharged, and that, by thus avoiding the necessity for violent paroxysms of cough, the diseased part may be kept more at rest, while, at the same time, suitable detergent injections may be employed So, too, Hastings and Storks (*loc. cit.*) performed this operation with the same objects in view, and, as has been seen, endeavored to secure them by leaving a piece of gum catheter in the wound, so as to maintain the direct communication between the cavity and the external air. One of the results obtained, then, by this operation, as performed by Storks and repeated recently by Mosler, is a certain degree of rest for the walls of the cavity and the tissue immediately surrounding. It is of course evident that, as the cavity will freely communicate with the air, both by the bronchial tubes and by the canula, its walls will still be subjected to ordinary atmospheric pressure which will suffice to prevent any marked collapse of the cavity. But, on the other hand, as the air which enters from the bronchi during inspiration can immediately and freely escape, it will be found that the respiratory movements of the lobe containing the cavity become much diminished. In addition to this, the regular and free discharge of the purulent secretion of the cavity through the canula, will, as would be anticipated, and as has been shown by experience, lessen the frequency and severity of the cough. In rare cases, the communication of the cavity with the bronchi is such that the pus which forms readily passes into the air-tubes and is expectorated with ease. But most frequently, the process of emptying a cavity by cough is a wearisome, painful, and injurious one; and, as the paroxysms are often excited by eating and drinking, it is by no means rare to have such frequent vomiting from this cause as to seriously interfere with nutrition It can scarcely be doubted that the avoidance or mitigation of this violent cough, and the comparative rest given

to the cavity, would favour cicatrization of its walls and tend to prevent its extension.

The other advantage which is gained by this mode of operating (inserting a comparatively large canula) is the power of disinfecting the contents and walls of the cavity by injections. Although mention is made by some of the earlier writers of the use of detergent applications, it cannot be shown that such injections into lung cavities were really employed before their use by Mosler. It appears to me, however, that this author has attached undue importance to the mere disinfection of the secretion of the cavity as compared with the modification of the morbid action in the wall of the cavity itself. The opportunity of endeavouring to bring about such a modification is, indeed, to my mind, the greatest advantage derived from this operation. It can be effected when a canula has been allowed to remain in the opening by injecting directly into the cavity a suitable amount of such dilute solutions as may seem proper. Mosler introduced weak solutions of iodine and carbolic acid in one of his cases by atomization, but appears to have aimed chiefly at the disinfection of the contents of the cavity. Up to this time, I have limited myself in the local treatment of phthisical cavities, to the repeated injection, through a delicate canulated needle, of small amounts of solutions of iodine of various strengths, the canula being introduced into the cavity at the time of each injection and immediately withdrawn. As thus performed, of course the operation does not affect the relations of the cavity to the external air, nor does it in any way facilitate the escape of the secretion. The sole value of such treatment must then depend upon the question whether we are able to modify beneficially the morbid action on the surface of pulmonary cavities and in the surrounding diseased lung tissue. Dr. Hutchinson (*loc. cit.*), in speaking of this point, says:—

"Moreover, the opinion that injections may be of service in the treatment of phthisis rests, we think, upon a mistaken therapeutic basis. In certain conditions of the serous membranes, they are unquestionably useful by exciting inflammation, but a little reflection will convince any one, who has abandoned in whole or in part the theory which makes phthisis the result of tubercular deposit, that this is the very last thing to be desired in the disease. The object aimed at in the management of phthisis, and especially in those local cases in which Dr. Pepper thinks the injections are most likely to be useful, is to allay inflammatory action, not to excite it. We therefore are unable to see how they can be productive of any good; on the contrary, if they light up an inflammatory process in the walls of the cavity, this will be very likely to extend to the circumjacent tissue, and thus the disease, which may have been previously held in abeyance, be roused into activity."

We must remember, however, that the terms *allaying* and *exciting* inflammatory action are purely relative ones, dependent upon the grade of morbid activity present. It can hardly be thought desirable, in a case where a caseous pneumonia is rapidly degenerating and breaking down in the centre, to attempt to *allay* the morbid action. It is probable that our best chance of preventing the ulcerative destruction of the whole af-

fected area would be, if it were possible, to apply a sufficiently powerful stimulus to *excite* a more healthy degree of cell action in the least affected parts, so that we might induce the development of fibro-cellular tissue, and thus limit the morbid process. We are perfectly familiar with the necessity and practical rules for graduating the stimulant or sedative characters of applications to external ulcers; and know well that there are many cases of unhealthy destructive ulceration which are most relieved by powerful alterative stimulant applications. There is a wide difference in the action of such substances when applied to the seat of the disease, and when applied to the surrounding healthy tissue; and applications which are most useful when made directly to a phagedenic ulcer, might, if made to healthy tissue in the neighbourhood, excite destructive ulceration.

So, too, with regard to circumscribed cavities, which are often lined with a layer of granulation-tissue which is constantly the seat of the formation of pus—the so-called "pyogenic membrane"—it is perfectly conceivable that some application might be made which would not *allay* the inflammatory action there, but *excite* a more healthy action by its alterative stimulant effect, and thus lead to a diminution of secretion, and a progressive contraction and cicatrization of the cavity.[1]

It is evident of course that the analogy between ordinary external ulcerations dependent on local causes, and ulceration of the lung tissue, must be drawn with great caution. It is the most hopeless feature of the latter that it is so frequently dependent upon a profound alteration of general nutrition, and that it is so apt to be associated with the presence of specific tuberculous formations in the lungs. Undoubtedly, therefore, in cases where the constitutional diathesis is marked, and the cavity is associated with diffused disease of the lung tissue, no one would think of undertaking a special treatment for the cure of the cavity. But, on the other hand, we meet with many cases where, without raising the question of their relation with tuberculosis, the constitutional affection is at a minimum, and the pulmonary disease is comparatively circumscribed, consisting of a cavity, secreting pus, and surrounded by more or less fibroid induration or cheesy infiltration of the lung tissue. We are familiar with the dangers in such cases —of gradual exhaustion, of hemorrhage, of progressive extension of ulceration, and of secondary infection of the constitution—and I can conceive of nothing more desirable in practical medicine than to be able to modify

[1] Dr. Hutchinson alludes to the development of connective tissue, "the effect of which will be to enlarge and keep open the wound made by the aspirator or trocar, and thus to allow the escape of the contents of the cavity into the pleural sac whenever this is not prevented by close adhesions." I cannot discover the force of this objection. The opening made by a delicate needle is so minute that it can scarcely allow the escape of any fluid, and if there are any cases of phthisis where pleural adhesions are sure to exist, they are precisely those where there is a marked development of fibro-cellular tissue in the lung.

the action of the inner surface of such a cavity, to check the amount of purulent discharge, and thus favour its gradual cicatrization and contraction. Under the most unfavourable view of the essential nature of such lesions, I can conceive of no objection to such an attempt, provided it can be made with safety; and when we are in possession of a method by which this can be effected, it seems to call for a patient and extended trial. In considering carefully the clinical histories of cases where lung cavities have undergone cure, it will be found that so long as active secretion of pus takes place from the seat of disease, with violent paroxysms of cough, there is little progress towards cure. But as the ulcerated surface heals, there is a development of fibro-cellular tissue around the cavity which continually tends to contraction. The discharge diminishes and the cavity is less frequently subjected to the violent distension occasioned by severe coughing. The chest-walls over the site become depressed and retracted, the heart is displaced *towards* the affected spot, partly by the traction of the contracting lung, partly by the pressure of the opposite lung, which undergoes compensatory hypertrophy and encroaches more and more upon the mediastinal space. It is thus seen that the phenomena which attend the cure of a lung cavity are similar to those with which all are familiar as marking the cure of a chronic pleurisy where the lung is so bound down by adhesions as to be unable to expand. And it will be noted that, in the cases reported in this article, the improvement in the cavity is attended, and to a certain extent measured, by the development of these phenomena of compensation.

I have already said that the most important object sought by this local treatment of lung cavities seemed to be this very modification of the morbid action of their lining surface; and it is on this account that the mode of treatment suggested in my former paper appears to me preferable to the operations of Storks or Mosler, although by these a free escape of the discharge from the cavity is secured, and its walls are more immediately afforded rest. It enables us to bring any desired amount of an appropriate solution in contact with the inner surface of the cavity, or with any part of its wall; while at the same time it is entirely free from the objection of maintaining local mechanical irritation, such as might result from the prolonged presence of a canula. In order to show how simple a mode of treatment it is, and at the same time how well calculated to fulfil the chief indication we have laid down, I will ask attention to a brief description of the manner in which I have carried it out during the past six months.

The cavities which have hitherto presented themselves for treatment have been in the upper lobe, so that all of the punctures which I have as yet made have been in the first, second, or third interspace. The point selected has been that at which the physical signs of a superficial cavity have been most intense. As a rule, the punctures have been made in the line of the nipple, although recently in two cases, owing to the increasing

contraction of the cavity and development of fibroid tissue, it has been necessary to select points half an inch inside or outside of the nipple line.

The apparatus consists simply of a very delicate steel canulated needle, like the finest hypodermic needles, but about three inches in length, and an ordinary hypodermic syringe capable of holding twenty-five minims. In my first experiments I used an aspirator, but as the withdrawal of any pus is not contemplated, it is in every way preferable to employ the more simple apparatus above mentioned.[1]

In order to diminish the pain caused by the puncture, I have always employed local anæsthesia by freezing, and with this succeed in effecting the treatment without causing a murmur of complaint. Occasionally small filaments of nerves have been pricked, and have caused tingling, radiating pain, lasting for a few moments. The injections have been given while the patients were in a sitting posture, and I have usually directed a full breath to be taken before the puncture is made, and to be held during the injection. The time occupied by each injection does not exceed thirty seconds. The depth to which it will be necessary to introduce the needle will vary, of course, in different cases; in the injections which I have myself made, I have introduced it from one and a half to two inches. With a very little care the ribs can be avoided; and a reference to the anatomical distribution of the nerves and vessels in the thoracic walls will always enable the puncture to be made so as to avoid them. The only fluid which I have as yet injected into lung cavities, has been dilute liq. iodinii comp In the earlier injections, this was used very weak (♏iv to f℥j), but for some time past I have increased it to ♏xij in a fluidrachm; the quantity has also been gradually increased from four to twenty-five minims for each injection. The entire absence of any signs of irritation assures me that, if it were desirable, larger quantities of stronger solutions might be injected. The results of injections of iodine have been so satisfactory in the limited number of cases in which I have employed this mode of treatment, that I have felt indisposed to use any other substance. But it is highly probable that other solutions, alterative, astringent, or antiseptic, may be found preferable in some cases. Unmistakable evidence of the entrance of the iodine into the air-passages has frequently been secured by the immediate perception of its pungent peculiar taste by the patients. I need only add that hitherto the injections have usually been made once a week on an average; and that, of course, every detail of internal treatment and dietetic and hygienic care has been continued, as far as practicable in hospital patients.

It remains, before giving the actual results of this method of treatment, to examine briefly what dangers and disadvantages attend it. We trust,

[1] Indeed, I believe that the use of the aspirator is not without danger, as the powerful suction brought to bear on the inner surface of the cavity may cause hemorrhage. (See Case IV.)

in the first place, that we have succeeded in showing that, *if the operation itself be free from danger*, there are clear indications which demand for it a full, fair trial. We are led to say this, by clinical experience and theoretical reasoning, even though so careful a thinker as Dr. Hutchinson believes "that it is not likely to result in good to the patient;" or though Dr. J. Hughes Bennett thinks the results of all operative treatment in phthisis to be "what an intelligent consideration of the pathology of the disease might have anticipated, a uniform failure."

Mosler believes that he has demonstrated that "the local treatment of lung cavities can be effected" even by the comparatively serious operative method he employed; and I do not see how his statement can be impugned. But as there are radical differences between his method and the one which I have hitherto employed, I shall limit myself to the objections which may be brought against the treatment of lung cavities by repeated injections through the chest-walls, effected by a delicate needle.

And first, with regard to the effects of the puncture itself upon the pulmonary tissue through which the needle passes in order to reach the cavity. In the cases where this mode of treatment would seem to be indicated, the cavity is usually very superficial, and is separated from the pleura only by a wall of firm fibroid tissue. It would be almost impossible, I conceive, for the mere passage of a delicate needle through this tissue to excite any injurious action. At times, however, the cavity is separated from the surface by a layer of lung tissue in a state of cheesy infiltration. In order to determine the influence of a puncture in such a condition, I made the following observation:—

Case I. *Hæmoptysis, followed by Phthisis; Rapid Extension of Disease; Repeated Injections of Iodine into a Spot of Caseous Infiltration; Death from Exhaustion; Autopsy.*—John D., æt. 29, a teamster, entered the Philadelphia Hospital March 11th, 1874. Has had scrofulous suppuration of cervical glands, and has also had syphilis. In June, 1873, had severe hæmoptysis, whilst doing some heavy lifting, and this was followed by cough. In December, grew worse, with increased cough, pain in left side, and hoarseness. In February of the present year, began to lose flesh and strength rapidly. In April, he began to suffer with intense hectic fever, exhausting night-sweats, and frequent cough; his emaciation and prostration were extreme, and he was confined to bed. Pulse frequent, feeble, and markedly dicrotic. Physical examination showed consolidation of left lung throughout, with moist crackling over upper lobe. On right side, there was dry crackling at apex.

May 8. Condition rapidly growing worse. As it seemed impossible to arrest the disintegration of the left lung, it was determined to try the local effects of injections of iodine upon the lung when in a state of caseous infiltration. Accordingly ♏viij of dilute Lugol's solution (1 pt. to 6 of water) were injected, the needle being introduced to depth of one and a half inch in the second interspace. The puncture caused no symptoms whatever.

10*th*. Same injection repeated.

11*th*. Pulse not dicrotic; he seems slightly stronger.

15*th*. Same injection repeated.

21*st*. Has same injection repeated. Has again begun to sink.

24*th*. Disintegration of left lung advancing. Same injection repeated.

29*th*. Death occurred from progressive exhaustion.

At the *autopsy*, disseminated tuberculosis of the right upper lobe was found. The left lung was in a state of caseous infiltration throughout. At several spots, puriform softening was beginning; this was further advanced at posterior part of the apex, where the disease seemed oldest. A very careful examination of the points where the injections had been introduced was made; but there was no trace left to indicate them. The portion of lung into which the needle had been introduced to the depth of over an inch was thoroughly consolidated, and remained quite firm. There was no staining of this area with iodine. The pleuræ were adherent over the whole upper lobe. No trace of the passage of the needle through the intercostal tissues remained.

It will be seen, therefore, that in this case five injections of dilute Lugol's solution were made at short intervals into a lung in a state of caseous degeneration, and that the iodine introduced was completely absorbed by the tissue, while there was not a trace of any mechanical irritation from the punctures, either in the intercostal tissues, the pleuræ, or the lung tissue itself. The results of this case have an important bearing upon the possibility of directing local treatment to superficial circumscribed indurations or caseous infiltrations of the lung tissue; but, for our present purpose, I would simply call attention to the fact that they agree with our reasonable anticipation, and with the results of clinical experience, in showing that the passage of a delicate needle through a layer of infiltrated lung tissue can be effected repeatedly without injurious consequences.

Finally, it may happen that the cavity is separated from the chest-wall by a thin layer of healthy lung tissue. It is frequently possible to decide as to the existence of such a stratum of vesicular tissue by careful percussion and auscultation, and I should be inclined to regard the presence of a demonstrable amount of healthy tissue between the cavity and the thoracic wall as a contraindication against the operation. Still, it has been demonstrated frequently (by Bretonneau, Velpeau, Koch, myself, and others) that puncture of the lungs with a delicate needle may be safely performed in the lower animals. Our knowledge of the results of penetrating wounds of the lung would lead us to expect little injury from the minute puncture effected by a delicate needle; and finally, it has been shown by some of the advocates of acupuncture that fine needles may be introduced even to a depth of two inches[1] into the healthy human lung, without any injurious effect.

As to the danger of hemorrhage, in the second place, all experience goes to show that it is very slight, even if it exists at all. Dr. Hutchinson (*loc. cit.*) states, "in one of the cases reported by Dr. Pepper a slight hemorrhage fol-

[1] Memoir on Acupuncturation, by Morand, translated by Franklin Bache, Phila. 1825, p. 65.

lowed the introduction of the aspirator; and the same accident occurred in the operations done by Dr. Mosler and Dr. Hastings." In Dr. Mosler's case, however, the statement is distinctly made in the account of the operation that "no hemorrhage occurred." Ten days subsequently a hæmoptysis occurred, and was soon checked by astringents blown through the canula. As the patient is stated to have already had several similar attacks before the operation, the last one can hardly, with fairness, be connected with the treatment. In Mr. Storks's account of the operation on Dr. Hastings's patient (*loc. cit.* p. 384), the only mention of hemorrhage is, that "the patient brought up two or three drachms of blood which had escaped into the cavity." It will be remembered that in this operation a long incision was made through the skin and muscles, and the wall of the cavity itself was opened to the extent of an inch, so that a good deal of blood must have flowed.

The trifling hemorrhage referred to as occurring in one of my own cases, took place the very first time I introduced a needle into a lung cavity. I am satisfied that it was connected with the effects of aspiration (for I was employing a Dieulafoy's aspirator), since it has never happened to me again to have the slightest hemorrhage caused, although I have repeated the punctures about twenty-five times upon the same patient, and not less than forty times more in various other cases. It will be further remembered that the puncture only involves the superficial layer of the lung where there are no large vessels, and is called for only in conditions of the lung-tissue where many of the bloodvessels are obliterated. I feel myself justified, therefore, in repeating "that the danger of serious hemorrhage is but slight, if the puncture be carefully performed" (*loc. ant. cit.*).

Thirdly. It has been objected that it is impossible to determine whether adhesion exists between the pleuræ over the seat of the cavity, and that consequently there is danger of allowing the escape of the contents of the cavity into the pleural sac, with the development of pleurisy or pneumothorax. It is true that in rare instances a lung cavity ruptures and gives rise to pyo-pneumothorax; but I believe all authorities will support the statement that for all practical purposes it may be assumed that there are adhesions over every chronic circumscribed superficial lung cavity. Not only so, but there is every reason to believe that, while the passage of the needle itself would, at the most, excite a slight localized plastic pleurisy if the membranes were healthy and non-adherent, the minute puncture of the lung would not give exit to any amount of air or pus capable of causing trouble.

It must be remembered, in performing this simple operation, that it is possible to wound either a vessel or a nerve by failing to regard the anatomical distribution of these structures. Of course it would be necessary in puncturing the chest at any point, just as in ordinary paracentesis, to bear in mind the course of vessels or nerves over that particular region.

In the treatment of lung cavities it will be found that the great majority of punctures require to be made in front, in the three upper intercostal spaces. By keeping as far inward as the nipple-line there is no artery or nerve of any importance exposed to injury. If, however, the position of the cavity should require the puncture to be made much external to this line, it would be desirable to introduce the needle as near the lower border of an intercostal space as it is safe to go without risking any injury of the intercostal artery. I think it probable that if the needle be advanced gradually, a small artery or nerve would be pushed aside and not transfixed. Certainly no accident of the kind has happened in my own experience, extending now over sixty-five punctures. Several times patients have complained of tingling pain shooting down the arm on the affected side, evidently from pricking of some little nervous filament of one of the thoracic branches of the nerves of the brachial plexus. But this pain has always been slight and very transient. In no case has there been the slightest hemorrhage into the tissues of the thoracic wall, or any evidence of irritation caused by the repeated punctures. I append the result of this treatment in the cases of this character in which I have so far employed it.

Case II. (Case II. in former communication.) *Chronic Phthisis; cavity at left apex, with disease of the lower lobe; repeated injections; temporary improvement; extension of disease; diarrhœa; death.*—John Wilson, æt. 35 years, a Finn, came into the Philadelphia Hospital February 7, 1874. Of a phthisical family, he had had symptoms of lung trouble for nearly three years. For the past three months there had been much acute pain over the left apex, and his other symptoms had been aggravated. He was emaciated and feeble. Physical examination revealed no positive disease on the right side. On the left side there was consolidation of the apex, with a superficial cavity extending from the first interspace to the fourth rib. There were also large and small bubbling râles over the rest of the lung anteriorly and laterally, with some weakness of the respiratory murmur. Posteriorly, above the spine of the scapula, loud bubbling râles were heard; and below, fine mucous râles. He was placed on use of cod-liver oil.

March 8. A delicate needle, attached to an aspirator, was introduced into the cavity to the depth of $1\frac{3}{4}$ inches through the second interspace. A few drops of sanious fluid entered the vacuum, and ♏ vij of dilute Lugol's solution were injected. The operation did not cause cough or hæmoptysis, and was followed by no pain, acceleration of pulse, or elevation of temperature.

10*th*. A delicate canulated needle, with an ordinary hypodermic syringe attached, was passed into the cavity, and ♏ xxv of dilute Lugol's solution ($\frac{1}{8}$ strength) were injected. The operation caused neither pain nor cough, and was followed by no irritation or elevation of temperature.

15*th*. Seemed brighter, and stated that he had been feeling better since the last injection. The cough certainly had been less troublesome. Again injected ♏ xviij of same solution. Careful attention was paid to internal treatment and arrangement of diet.

22*d*. Injected ♏ xx of same solution. Appeared to be improving.

A few days after this he felt so much relieved that he insisted upon going out of the hospital to attend to some business. While absent, a violent

storm occurred; he was much exposed, had a slight hemorrhage, severe pain at base of left chest, and on his return on April 3 he was much worse, with increase of cough and expectoration, continued pain and friction-sound at infero-lateral part of left chest.

A blister was applied over this spot, and he was placed upon use of quinia, digitalis, and opium.

For a few days there were evidences of some serous effusion in left pleura; but after this disappeared, coarse friction sound, with signs of rapidly developing consolidation of the lung, made their appearance. There was high hectic fever, and the loss of flesh and strength, which had before appeared to be checked, recommenced. Evidences of disease at the right apex soon made their appearance, and he began to suffer with diarrhœa, which was checked by opium and bismuth.

May 8. The signs of disintegration of the left lung advancing, another injection of dilute Lugol's solution was made into the cavity.

15*th*. He began to have blood-tinged expectoration, and was ordered vin. ergotæ in fluidrachm doses, and ♏ vj of dilute Monsell's solution were injected into the cavity.

24*th*. Disintegration of the lower part of the left lung still progressed. Injected ♏ xx dilute Lugol's solution into the cavity. Contraction of the upper part of left thorax had become more marked, and the heart was displaced upwards and to the left.

30*th*. Diarrhœa returned, and proved very difficult to control, causing extreme prostration. Soon after the discharges were controlled, increased hectic, cough, and expectoration appeared.

July 30. Since last note the condition of this patient has fluctuated, but on the whole has become worse. No further injections have been made. The cavity *appears* to be somewhat contracted, but the disease of the remainder of the lung and of the right apex has progressed so rapidly as to indicate a speedy termination.

August 14. He continued to sink, and died to-day, worn out with protracted diarrhœa.

At the *post-mortem* the *right* lung was found enlarged, tightly adherent over the upper lobe. On section, the whole of this lobe was in a state of cheesy infiltration, with several points of softening. Scattered through the middle and lower lobes there were crude yellow granulations. The anterior border encroached greatly on the mediastinal space. The *left* lung was much contracted, and throughout tightly adherent by dense white fibroid tissue, which formed a complete casing for the lung. On careful examination of the area through which the punctures were made, it was impossible to detect any trace of the passage of the needle. An incision was made into the upper lobe, which was almost entirely occupied by an anfractuous cavity. The anterior wall of the cavity was largely composed of pure fibrous tissue in places varying from $\frac{1}{12}$ to $\frac{1}{6}$ of an inch in thickness, with a small amount of lung tissue in a state of fibroid induration. The cavity was divided into sacs by various imperfect septa. The largest of these sacs lay upon the anterior part of the lobe with a fibroid wall not more than $\frac{1}{8}$ inch in thickness, and had been entered by the various injections. The lining membrane of this sac throughout was smooth, shining, and whitish, and entirely free from any cheesy formation. In other parts of the cavity there was a small amount of cheesy matter adherent to the walls. There was very little secretion in the cavity. The lower lobe was in a state of mixed fibroid and cheesy induration, with

here and there small centres of softening. The pericardium was tightly adherent to the concave surface of the left lung. The pericardial sac contained 8 ounces of turbid serum, but there was no appearance of inflammation. There were a few milky spots on the pericardium. The bronchial glands were greatly enlarged and in a state of cheesy degeneration. There was extensive ulceration of small intestine, and to a less extent, of the large intestine. The liver was fatty.

In this unfortunate case the injections were undertaken rather with the negative view of demonstrating their harmlessness than with any definite expectation that they would prove serviceable. The symptoms for three months before the patient came under observation indicated a rapid progress and extension of the disease, and when first examined, it was found that the entire left lung was hopelessly involved. Still the repeated attacks of pain which had been experienced about the left apex made it almost certain that the pleuræ were adherent over the seat of the cavity. And in fact it resulted that the injections which were practised (seven in all) did not cause the slightest irritation nor leave any trace that could be detected on post-mortem examination. The course of such cases is altogether too irregular to allow the slightest significance to be attributed to the temporary improvement which followed the first four iodine injections. It is true that the portion of the cavity into which the injections were directly thrown, presented an unusually favourable appearance, but no distinct contraction could be detected. All that can be safely deduced is that they were perfectly tolerated, and that they might have been safely continued had not the progress of the disease been precipitated by an intercurrent attack of pleuro-pneumonia from exposure, and by the supervention of intestinal ulceration.

The amount of blood in the expectoration, May 15, was too slight to allow any conclusions to be drawn as to the effect of the single injection of Monsell's solution.

Case III. *Hæmoptysis; Chronic Phthisis with large circumscribed cavity at right apex; injections of Iodine.*—Thomas Peyton, colored, æt. 46 years; admitted to the Philadelphia Hospital May 1874. Enjoyed good health until June 1872, when, while working, he had a severe hæmoptysis, followed by two others in course of twenty-four hours. This was followed by cough and dyspnœa, with abundant purulent expectoration. He lost flesh rapidly at first, then recovered somewhat and returned to work in the course of two or three months. He had two or three small hemorrhages subsequently, but continued to improve until the summer of 1873, when he was obliged to quit work for a few weeks, after which he resumed it and continued until May 1874, when he was obliged by dyspnœa to abandon it and enter the hospital. He has usually kept in pretty fair condition; has enjoyed good appetite; had night-sweats in 1873, and again since admission. On admission there were undoubted physical signs of a large superficial cavity with thick walls at the right apex, reaching down to the third interspace. He was placed on use of the following mixture: quiniæ sulph. gr. xxiv; acid. sulph. dil. f℥ij; inf. gentianæ comp. f℥vj; ft. sol. S.—Tablespoonful thrice daily in water.

20*th*. A delicate canulated trocar was passed through the second intercostal space into the cavity, and ♏ xxx of dilute Lugol's solution (one-eighth strength) were injected. No unpleasant symptoms attended the operation.

27*th*. The same injection was repeated. The patient was very nervous, and said it increased the rheumatic pain in his back; no further injections were practised.

July 25. The patient has continued in the hospital, and has used steadily the prescription given above. He has improved considerably, coughing but little, and suffering less from dyspnœa. The physical signs remain as before, save that there is increasing contraction at right apex, and evidence of very little secretion in the cavity.

In this case, also, the size, duration, and superficial position of the cavity rendered it highly probable that the pleuræ were closely adherent over its site. The injections did not produce a single unfavourable effect. The pulmonary symptoms improved steadily, though slowly; but it is difficult to say how much, if any, influence should be attributed to the intra-pulmonary injections which were only twice employed.

Case IV. *Chronic Phthisis, with large circumscribed cavity at right apex; Incipient disease at left apex; Repeated injections of Iodine; Marked improvement* (Case I. in former article).—W. S., æt. 29, has a strong hereditary disposition to phthisis, having lost his father, mother, and one brother with that disease. He is markedly chicken-breasted, and lame from severe coxalgia. He has been a metal-polisher, and was attacked with cough in August 1872. In October 1873, he had hæmoptysis, after which he failed rapidly; lost flesh and strength; had marked hectic and dyspnœa. There was much pain over the right apex, troublesome cough and abundant purulent expectoration.

There was no recurrence of hæmoptysis, but his condition remained about the same, with occasional fluctuations, until the early part of the present year, when he suffered severely with increased cough and hectic. On February 17, 1874, his condition was found to be as follows: He is much emaciated, and is very easily fatigued. There are no marked digestive symptoms. His breathing is very short, and this is much increased by exertion, so that it is difficult for him to ascend a single flight of stairs. His cough is painful, exciting pain especially on the right side of the chest, but is not very severe at present, and is attended with but a moderate amount of purulent expectoration. The frequency of the pulse is somewhat variable; at present it is 108.

Upon physical examination there is on the left side some roughness of the respiratory murmur, and a few crackling sounds at the apex.

On the right side there is tympanitic resonance, even on light percussion, from the clavicle down to the fifth rib; the most marked (amphoric) tympany is heard at the middle of the second interspace. There is cracked-pot sound for two and a half inches to the right of the sternum from the second to the fifth rib. Auscultation reveals blowing breathing on inspiration and expiration over this whole area—the character of the blowing, however, varying at different points. Over the seat of cracked-pot sound it is very superficial and is rather shrill and high-pitched, and accompanied with large, moist, and gurgling râles. Outside of the line of the nipple it

is larger, lower-pitched, and free from râles. There is intense pectoriloquy over this entire area.

His treatment has been very varied, but without any permanent relief, and the course of the case has been gradually downwards.

On February 24th, the No. 1 needle of Dieulafoy's aspirator with the syringe attached was introduced in the second interspace on a line with the right nipple to the depth of $1\frac{7}{8}$ inches, and was followed by the escape into the vacuum of a few drops of offensive watery pus. About ℥iv of a very dilute Lugol's solution ($\frac{1}{30}$ strength) were then injected through the canula by a hypodermic syringe.

The operation was followed by loose, rattling cough, and the expectoration of about three fluidrachms of fresh, frothy blood. He was immediately put to bed, and the cough and hemorrhage soon stopped. His temperature in the evening and the following morning was only 99° F.

28th. The injection was repeated in same manner, ℥vj of iodine solution of double former strength being used. There was tingling pain down the right arm while the needle was in place, but no other symptoms attended or followed the operation.

March 5. Since the last puncture, he has been feeling very comfortable. There has been no hectic; the cough is less severe, the sputa more scanty and whitish. He is bright and cheerful, and states that his dyspnœa is greatly relieved. The same needle was introduced to the same depth at a point one-eighth of an inch nearer to the sternum. The puncture was immediately followed by a rapid flow of fresh, frothy blood into the vacuum, about one and a half fluidrachms escaping. The pump was detached, and ten minims of iodine solution were injected. He was put to bed immediately, but scarcely any cough and no hæmoptysis followed.

8th. The patient is brighter and more cheerful than for months past. There is no hectic irritation, the temperature never rising above 99° or 99.5°. The pulse ranges about 84. His breathing is so much relieved that he has walked up three long flights of stairs without much dyspnœa. His weight is now 107 pounds. The cough is but little troublesome, and only a few white, frothy sputa are raised. Auscultation shows that many of the râles formerly heard over the right apex have disappeared. There has also been some increase in flesh. All internal medication was now discontinued.

Before this he had been taking cod-liver oil, a pill of quinia, digitalis and opium, and a sedative cough mixture.

10th. Twenty minims of same solution were injected at a spot a little outside of the former puncture. The aspirator no longer used. A strong iodine taste was immediately perceived.

15th. Fifteen minims of same solution injected. During the past week he has had more cough and expectoration, and has felt weak and chilly; partly on account of very low temperature in ward, partly on account of the withdrawal of internal medication.

22d. Twenty minims of same solution injected; no unpleasant results.

30th. Fifteen minims of a stronger solution (Lugol's solution ℥x to ʒj of tepid water) injected.

April 3. Not feeling so well; increase of cough and expectoration and hectic fever. Also suffers from indigestion. Was ordered quiniæ sulph. gr. ij t. d. also strychniæ sulph. gr. $\frac{1}{30}$; acid. nitro-muriatic. diluti ℥x; liq. pepsin ʒj t. d.

9th. Injected ℥xxv of Lugol's solution (one-seventh strength).

10*th.* Slept well last night and feels a great deal better; has had hardly any cough. Weight 109 pounds.

17*th.* Injected ♏ xv of same solution. Bowels costive; ordered laxative pill of colocynth and belladonna. The acid tonic mixture ordered on the 3d now stopped; quinia to be continued; and mist. ol. morrhuæ cum calcis lacto-phosphatis f℥ss t. d. ordered.

25*th.* Injected in same manner.

May 3. Repeated same injection. Patient improving. Is able to sleep well. Has no hectic. Coughs very little, and expectorates purulent matter in moderate amount. Is out every day walking over a mile.

8*th.* Injection repeated with ♏ xxv of Lugol s solution (♏ xij to ♏ xlviij of warm water). Weight increased to 111½ pounds.

Same injection repeated May 15th, 24th, and 30th; and June 5th and 14th. On introducing needle at usual spot in second interspace, the point was evidently imbedded in dense tissue instead of entering cavity. This has been growing more and more marked for some weeks past. The injection entered with difficulty and only ♏ xv were introduced.

June 21st and *July* 1st ♏ xxv of same solution (1 to 5) were injected in second interspace, three-quarters of an inch outside of nipple line.

6*th.* Repeated injection, and found difficulty in forcing fluid in, so that only ♏ xij were injected. Continues to improve, although a good deal affected by the hot weather. Expectoration very scanty, not more than f℥ij daily.

15*th.* Still more difficulty experienced and only ♏ vij injected. This is evidently owing to increased development of fibroid tissue in wall of cavity leading to thickening and contraction.

21*st.* Injected ♏ xxv in first interspace in the line of the nipple without any difficulty; severe tingling pain coursed down right arm for a few moments.

August 17. No injection since last date, owing to my absence from the city. For past three or four days, he has had some catarrhal irritation, in consequence of imprudent withdrawal of his underclothing. He has continued in fair condition, with very little cough and expectoration. He has for several months spent the greater part of every fine day out of doors, walking considerably. There has been scarcely any hectic fever, as indicated by the thermometer. He has gained flesh slightly; appetite and digestion good. The physical signs indicate no extension of disease in left lung. There is increased contraction at right apex. On percussion, there is marked diminution in the cracked-pot sound; and tympanitic resonance is less superficial and readily developed. There is still marked blowing breathing and pectoriloquy; but respiration is accompanied with much fewer râles than formerly.

In examining this history, I think it will be granted that it was far from being a favourable case for treatment, when we add to the marked family tendency to phthisis and the previous scrofulous affection, the advanced disease of the right lung, and the incipient trouble at the left apex. And yet it is unquestionable that during a period of six months, in which time twenty-three injections have been made, there has been a progressive improvement both in the general and local conditions. He has gained a few pounds of flesh, but has gained vastly more in vigor and power of exercise. His spirits and morale have greatly improved. Cough has

almost left him, and the expectoration is very trifling. There has been very slight progress in the signs of disease at the left apex, while there has been an evident contraction of the large cavity at the right apex, as shown by the greater retraction of the ribs, and the increasing displacement of the heart towards the right side, as well as by the increased resistance to the introduction of the needle.

Case V. (Case III. former article.) *Chronic Phthisis of Right Lung with large Cavity at the Apex; repeated injections of Iodine; Improvement.*—James Hill, æt. 27, was admitted to my ward in the Philadelphia Hospital. His father died of phthisis; he himself enjoyed good health until November, 1871, when he had an attack of rheumatism. In April, 1872, he began to be troubled with cough and pain in the right chest; the cough was at first dry, but later has been accompanied with purulent sputa. He first spat blood in July, 1872, and since then he has had quite frequent small hemorrhages. He has suffered much from pain in various parts of the right lung. He has had comparatively little hectic fever, but has lost much flesh and strength.

He was obliged to give up work in November, 1873. His weight on admission was 117½ pounds. Marked dyspnœa on exertion, pulse 120 when quiet.

Physical examination shows contraction and comparative immobility of the right side; enlargement of the left side, with slight curvature of the dorsal spine, and deviation of the sternum. The left lung is hypertrophous and healthy. There are the physical signs of a quite large cavity at the right apex, with marked thickening of the pleura and induration of the lung below. The apex-beat of the heart is just to the right of the sternum.

Over the right infra-clavicular space, down to the third interspace there is deep-seated tympanitic resonance, which on strong percussion is amphoric with slight cracked-pot sound; cavernous breathing, both in inspiration and expiration, with bubbling râles with amphoric echo, and marked pectoriloquy for the spoken and whispered voice. On March 8, the No. 1 aspirator-needle was introduced in the second right interspace a little outside of line of nipple to the depth of one and seven-eighths inches, and evidently entered a cavity. About seven minims of dilute Lugol's solution were injected. The operation produced a paroxysm of spasmodic cough, but was followed by no hæmoptysis or irritation. On the following day there was a little blood-stained expectoration, such as he frequently had.

March 15. Repeated same injection, using ♏ xv.

22*d*. Injected ♏ xx of same solution.

April 9. Injected ♏ xxv.

10*th*. Has been taking much subnitrate of bismuth and pepsin for his dyspeptic symptoms. Now ordered syr. ferri iodidi gtt. xv t. d.

17*th*, 25*th*, and *May* 3. Again injected ♏ xxv of dilute Lugol's solution (1 pt. to 7 of tepid water). He has gained 6½ lbs. since admission.

May 8, 15, and 24. ♏ xxv of stronger solution (1 part to 5 of water) were injected. Not the slightest inconvenience has followed any of the injections.

30*th*. Injected ♏ xviij of this last solution in the third interspace.

June 5, 14, 21, and 29; *July* 6, 16, 21, and 28. Repeated same injection, but in second interspace as formerly.

August 17. On my return to the city, I find him in bed with a marked attack of purpura. He has been ordered fresh vegetables and fruits freely,

and is getting well of it rapidly. His general condition is favourable. There is very little cough or expectoration, and the physical signs indicate a tendency to still further contraction of the right chest, especially at the apex. The heart's action is still excited. Until the development of the attack of purpura he has been able to exercise freely out of doors. No injection since last note.

In this case, as in the former, the prognosis was rendered unfavourable by the large size of the cavity and the implication of the rest of the lung, as well as by the hereditary predisposition of the patient, the frequent recurrence of hemorrhage, and the marked emaciation, dyspnœa, and prostration. On the other hand, the tendency of the disease to assume a fibroid form, and the evident attempts at compensation in the retraction of the chest, the hypertrophy of the left lung, and the displacement of the heart were favourable elements of prognosis. Still it will not, I think, be doubted that the progress of the case has been exceptionally favourable; so that, while it is very certain that the local treatment above described was not in any way injurious, it is altogether probable that it has been productive of good in favouring contraction and cicatrization of the cavity.

Case VI. *Chronic Phthisis; frequent Hemorrhages; large Cavity at Right Apex; Repeated Injections of Iodine; Marked Improvement.*—W. E., æt. 43, a tall and heavily-built man, a labourer, of very intemperate habits, was admitted to the Philadelphia Hospital 19th March, 1874. His father and one of his brothers died of phthisis; the rest of the family are very healthy. He had several attacks of gonorrhœa, and one attack of syphilis, followed by very mild and transient secondary symptoms. He was very much exposed in consequence of his work and intemperate habits, but was not subject to catarrh. Had severe attack of typhoid fever in spring of 1870. In the fall of that year, cough began with expectoration of muco-purulent matter, occasionally containing small proportion of blood. In October and November he had frequent large hemorrhages; dyspnœa became marked, and he lost flesh and strength rapidly. He gave up work then and has been able to do very little since. Since then his condition has fluctuated from time to time. During summer of 1873 he had a good deal of purulent expectoration and occasional hæmoptysis, but had some periods of comparatively good health. At beginning of the fall he lost flesh and strength still further, and entered the hospital in October. He went out in January and returned in March. At that time, his weight was 149 lbs. His dyspnœa was extreme, and he had great difficulty in going up stairs. Cough was very troublesome and attended with abundant blood-tinged expectoration.

On physical examination, the thorax is rather narrow with increase of antero-posterior diameter. The apex beat of heart is in fifth interspace just within left nipple. No clubbing of fingers. Enlargement of capillaries of nose and cheeks.

At the right apex there is large tubal tympanitic resonance over inner two-thirds of infra-clavicular space, and over the outer third dulness on percussion. Posteriorly there is dulness down to a little below spine of scapula. At left apex the percussion resonance is a little higher-pitched than normal. Elsewhere it is normal.

Auscultation at right apex reveals loud, dry, cavernous breathing down

to third rib anteriorly, and, over third interspace, moist crackling with prolonged expiration. Posteriorly there is large blowing breathing over apex. Below, respiration is normal anteriorly and posteriorly. There is distinct pectoriloquy over the infra-clavicular and supra-spinous spaces. At left apex anteriorly, there is feeble respiratory murmur, with dry crackling over upper lobe anteriorly. On palpation the vocal fremitus diminished all over thorax; same at right apex. He was ordered cod-liver oil and a cough mixture containing cyanide of potassium.

April 9. His condition appeared stationary. He suffered much from dyspnœa, weakness, and cough. An injection of ♏ vi dilute Lugol's solution (1 part in 10 of water) was made into the cavity through the second interspace in line of nipple. This was followed by a severe spell of coughing, lasting an hour, and requiring chlorodyne for its relief.

17*th*. Injected ♏ xv of same solution. Has had rather more cough than before first injection.

25*th*. Same injection repeated.

May 3, 8, 15, and 24. Injection repeated, using ♏ xv to xx of solution varying from 1 part Lugol's solution to from 9 to 6 parts of warm water. His weight increased 11 pounds, to 160. Better in every way; cough greatly relieved; has had no blood-stained sputa for some time. Is now able to walk considerable distances.

June 5 and 9. Same injection repeated.

21*st*. Injected ♏ xxv of Lugol's solution (1 part to 5).

June 29 and *July* 6. Injections caused some pain owing to difficulty in introducing fluid, apparently owing to increased induration and contraction of tissue at point of puncture.

July 8. Injected ♏ xxv of same solution in first interspace in line of nipple, without slightest difficulty, and with production of no cough or pain. The needle was introduced $1\frac{5}{8}$ inches.

16*th* and 21*st*. Repeated same injection at same point.

August 17. Owing to absence from the city no injection has been made since last date. For the past two or three months has spent almost the entire day in the open air, his strength has been increasing, and he now walks as much as five miles a day without fatigue. His breathing has become much easier; is able to carry a bucket of water up to the third floor without dyspnœa. For the past eight weeks his cough has been rapidly decreasing and during the past month has ceased, and there has been no expectoration. There is an entire absence of hectic fever. His general appearance is excellent, and his appetite and digestion are good.

The right apex is motionless during respiration; there is no increased contraction of right apex; tympanitic resonance is less distinct, it being best marked over inner half of first and second interspaces. There is large diffuse blowing over outer part of first and second interspaces, which toward sternum becomes almost cavernous. There is less dry crackling over the left upper lobe with improved respiratory murmur. He continues to take cod-liver oil and two ounces of whiskey daily, but needs no cough mixture. To-day repeated the same injection through first interspace.

In this case, also, although a more favourable prognosis was justified than in the two last ones, it must not be forgotten that the patient's condition, when the use of injections was begun, was worse than at any previous time, and that evidences of incipient disease of the left apex had

made their appearance. The improvement which has taken place during the continuance of the local treatment is very positive and gratifying, and shows itself by disappearance of cough and expectoration, by entire cessation of hæmoptysis, by relief of dyspnœa, and by gain in flesh and strength.

The momentous importance of determining the actual clinical value of any mode of treatment which claims to be of use in pulmonary phthisis, forbids any rash conclusions drawn from insufficient data. In March last I stated that "the practical value of this mode of treating pulmonary diseases is as yet uncertain." Subsequent experience, although by no means sufficient yet to justify a claim of curative powers for it, has certainly strengthened its position. In the first place, it is evident from the record of cases here published that the injections of iodine reach the lung cavity and exercise a decided action upon its lining surface. This is shown by the depth to which the needle is introduced, by the strong and unmistakable taste of iodine frequently perceived after the injections; and by the paroxysms of cough caused by the first injections in each case. It is evident also that this action proves not only to be unirritating, but to tend to a diminution of the morbid sensibility of the cavity walls, and to a healthy modification of the cell-action there. This is shown by the fact that, although the amount and strength of the injections have been considerably increased, in each case they have ceased to produce any cough. It will be remembered that in the earlier injections very small quantities (♏ iv to vij) of very weak solutions (Lugol's solution ♏ ij to iv to ℥j of water) were used, but they have lately been increased to ♏ xxv of a mixture of 1 part Lugol's solution and 5 parts of warm water. It may be doubted if the small and feeble injections at first employed could produce any marked effect upon the lining surface of a large cavity; but this power will scarcely be denied to the much larger and stronger injections lately used. Their action further appears to be beneficial, and the modification of the cell-action in the walls of the cavity to be in a healthy direction, since during the continuance of this treatment there has been in each case a marked improvement in the soreness about the cavity, and, even more markedly, in the amount of cough and expectoration. I do not think that the evidence afforded is yet sufficient to prove that these injections have led to partial cicatrization and contraction of the cavities; but the improvement in the physical signs carefully noted above, certainly seems to indicate it. If they succeed in effecting this, it will presumably be by so modifying the cell-action in the walls of the cavity as to lead to a production of more healthy lymph capable of developing into fibro-cellular tissue, limiting the enlargement of the cavity, and ultimately by its organization and contraction tending, in conjunction with other agencies, to diminish its size. It must be noted that in two cases (IV. and VI.) the increasing density of the tissue through which the needle had been passed, and the increasing difficulty of effecting the injection at the original spot, would

seem to point to this change in the walls of the cavity. This question must, however, be settled by more prolonged observation.

It is finally evident that, if these injections are capable of disinfecting the contents of a lung cavity, and of so modifying the morbid action in its walls as to diminish the suppuration, they may be of the greatest value by lessening hectic irritation, and further by diminishing one of the greatest dangers of chronic phthisis, the liability to constitutional infection, and the development of diffuse miliary tuberculosis. It may be maintained in opposition to all here advanced that the favorable changes in the three cases last reported (IV., V., and VI.), are accidental and temporary, and merely such as are seen from time to time in the course of many cases of chronic phthisis. I can only vouch for the clinical records as presented; and call attention to the facts that these three cases were doing badly, despite careful internal treatment, until the beginning of the use of intra-pulmonary injections; that since then their improvement has been such as would be rather surprising in a single case, but much more remarkable in three unfavourable cases treated simultaneously under rather unfavourable circumstances; that the course has been uniform in all the cases, and marked by the same changes; that it has been attended with positive improvement in the physical signs; and that this steady gain has seemed to the patients themselves, and to all who have watched them, to be directly connected with the treatment employed.

In concluding our study of this question the following points appear to have been established:—

1. That the idea of opening lung cavities by an incision through the chest-walls is at least as old as Baglivi (probably much older); but that, owing to the very imperfect character of early clinical records of thoracic diseases, it is difficult to show that such an operation was actually performed before the last century (Barry), or more probably the present one (Hastings and Storks).

2. That the idea of conducting continuous treatment of such cavities by local applications made directly through the chest-walls, has been seriously entertained only within the past few years.

3. That the possibility of puncturing the lung in a state of health with delicate needles without injury, was demonstrated in a few instances by the advocates of acupuncture; and more recently, in the lower animals, by Koch and others.

4. That the operations of Storks and Mosler have shown that lung cavities are very tolerant of external interference, and that they may be cut down upon and opened, canulæ introduced and retained, and various medicinal agents injected in solution or spray (Mosler).

5. That the independent observations reported in full in this paper have shown that the continuous treatment of lung cavities by repeated injections by means of delicate canulæ may be conducted without pain, hemorrhage,

traumatic irritation, or interference with internal medication and hygienic measures.

6. That the cases which are best adapted for this local treatment are those where a single, superficial, and circumscribed non-tuberculous cavity exists; but that even when there is implication of the rest of the lung, or incipient disease of the opposite lung, some benefit may be expected.

7. That the mode in which such local treatment does good, is chiefly by altering the character of morbid action in the walls of the cavity, diminishing the amount of purulent formation, as well as the degree of hectic irritation and the danger of constitutional infection. That a certain amount of rest for the walls of the cavity is secured by the marked relief afforded to the cough. Also that it is indicated, by the progress of the cases above reported, that this treatment may favour the cicatrization and contraction of such cavities.

8. That in the cases in which it has been employed (in which over seventy injections have been given), it has shown itself free from all danger, and of a *certain degree of positive clinical value*, since, during its use, uniform improvement to an exceptional degree has taken place in both the general and local conditions of the patients.